Northern Virginia LID Supplement

Developing A Water Quantity Sizing Approach for LID Design

May 27, 2008

Northern Virginia Regional Commission

NVRC was charged with developing a LID Supplement that met the needs of the Northern Virginia jurisdictions

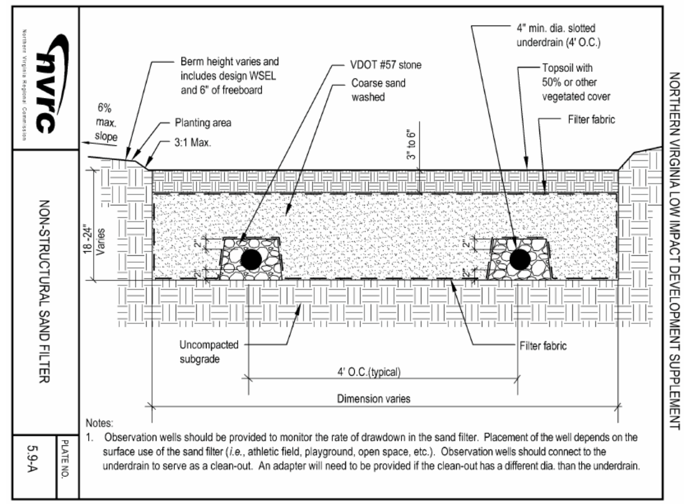
- **Formulate a unified Northern Virginia regional approach for LID site development design**
- **Streamline and simplify the complexity of the comprehensive LID design philosophy**
- **Allows the site developer to design a LID site and the reviewer to replicate and verify that it has been designed appropriately**

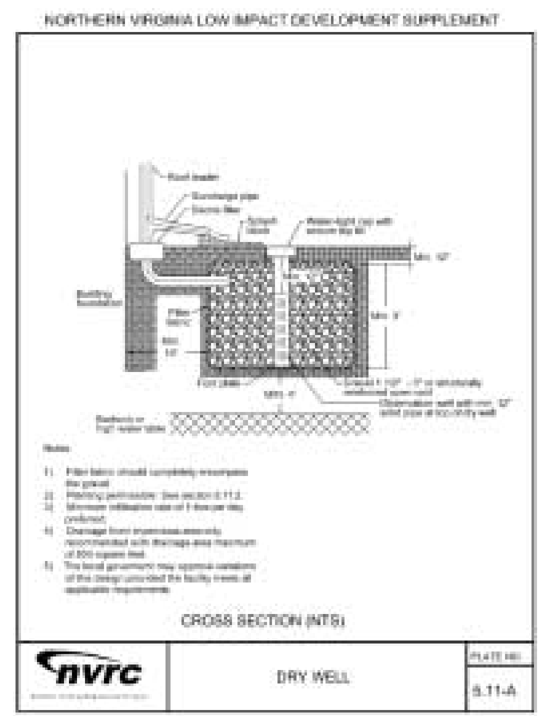
Northern Virginia LID Supplement content

- **LID philosophy**
- **Applicable stormwater regulations**
- **Proposed LID sizing approach**
- **LID practices**
- **Expanding the use of LID**
- **Checklist**
  - **Site planning**
  - **Design**
  - **Construction**
  - **Operation and maintenance**

Northern Virginia LID Supplement BMPs

1. **Pervious pavements**
2. **Reforestation**
3. **Vegetated roofs**
4. **Bioretention cells**
5. **Vegetated swales**
6. **Vegetative box filters**
7. **Filtration devices**
8. **Pocket wetlands**
9. **Non-structural sand filters**
10. **Level spreaders**
11. **Dry wells**
12. **Rainwater catchment systems**





The LID Supplement is in Final Draft Review

- **The LID Supplement provides tools that together guide the site design process**
- **Missing from the Supplement is a water quantity sizing approach**
- **The LID Workgroup wants conformance with State requirements before finalizing a sizing approach**

Local, State, and Federal regulations aim to protect downstream bodies of water.

The Sizing and Selection Approach for LID Design Should Replicate Predevelopment Conditions As Feasible

- **Infiltration volume**
- **Peak discharge control**
- **Water quality volume**
- **Adequate outfall analysis**
- **Credits**

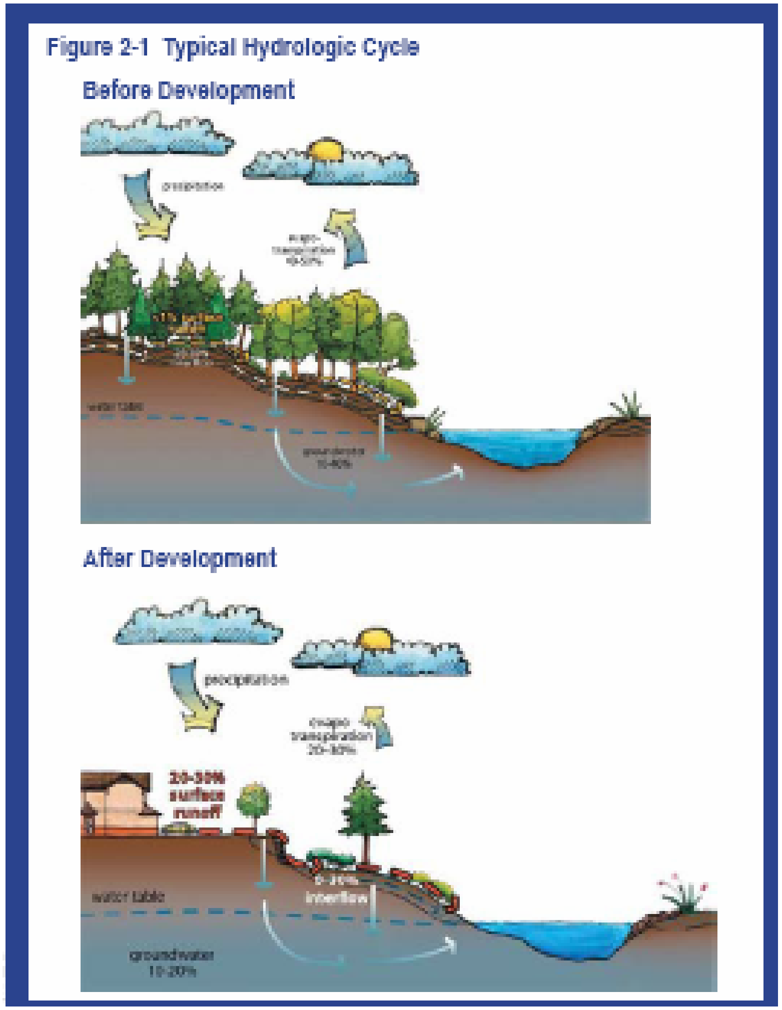
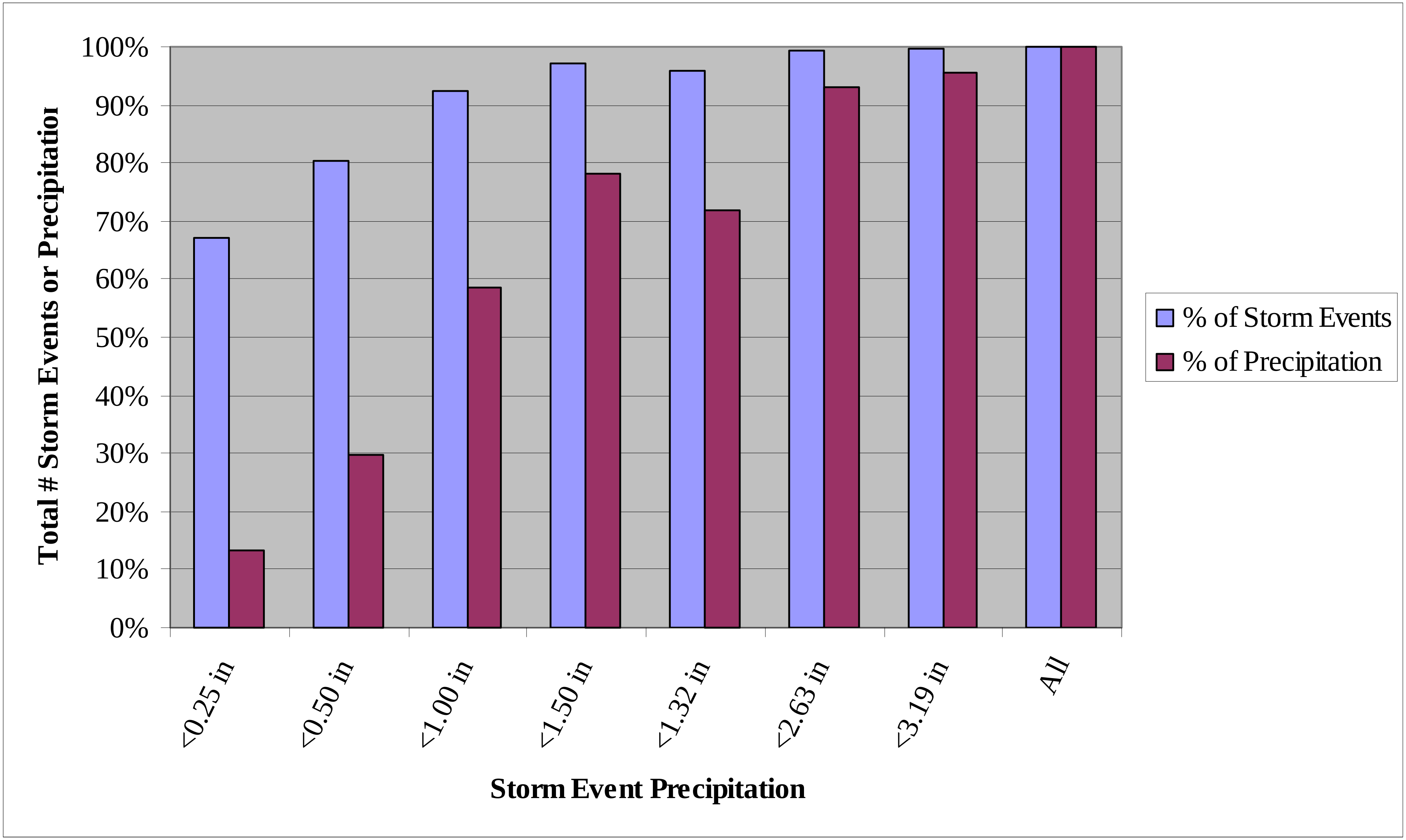


Figure 2-1 Typical Hydrologic Cycle

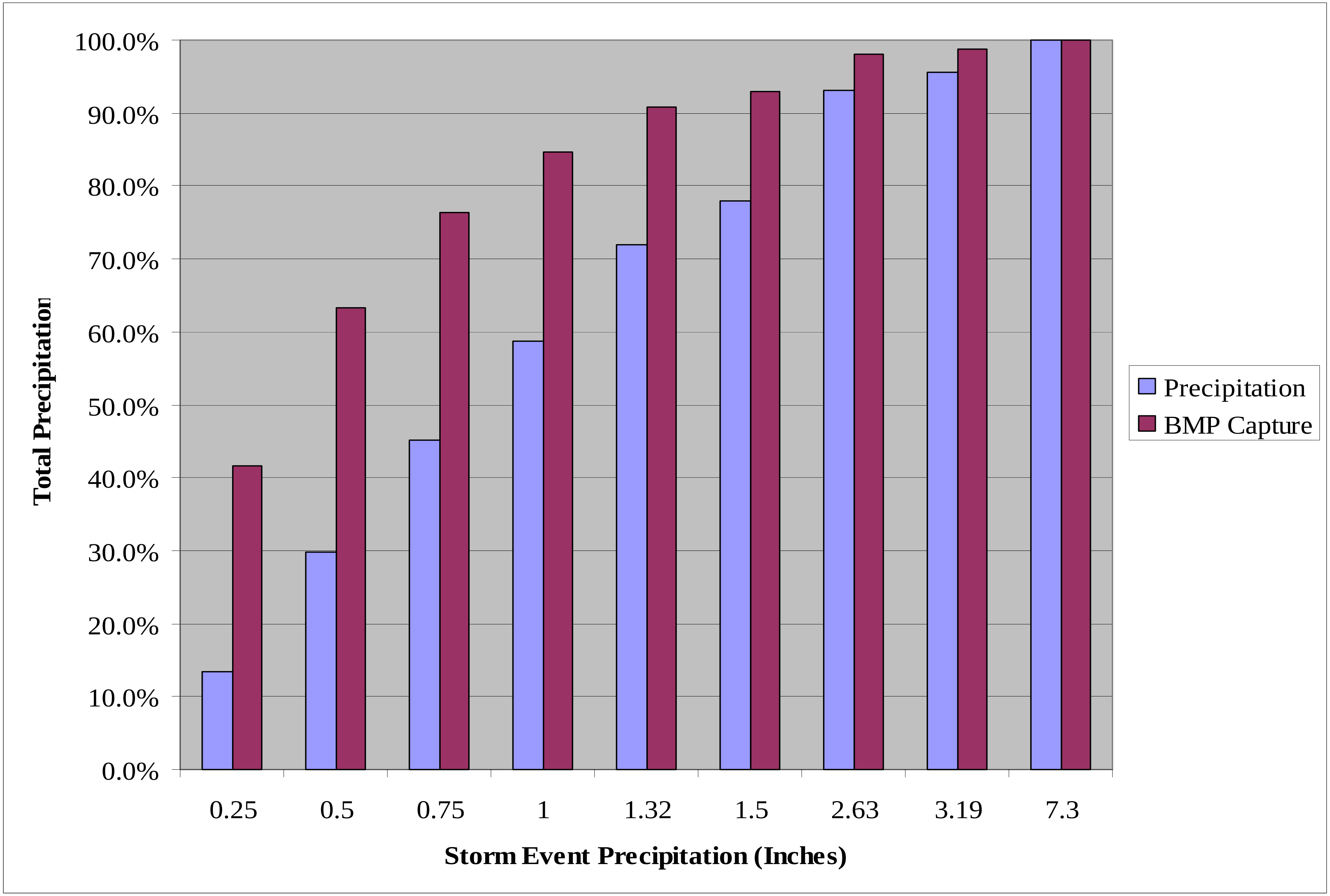
Precipitation Frequency of Occurrence & Cumulative Volume

Data source: Reagan-National Airport (May 1948 through January 2006)



Precipitation & Cumulative Volume Captured For Water Quantity Sized BMPs

Data source: Reagan-National Airport (May 1948 through January 2006)



Precipitation & Cumulative Volume Captured For Water Quantity Sized BMPs

Data source: Reagan-National Airport (May 1948 through January 2006)

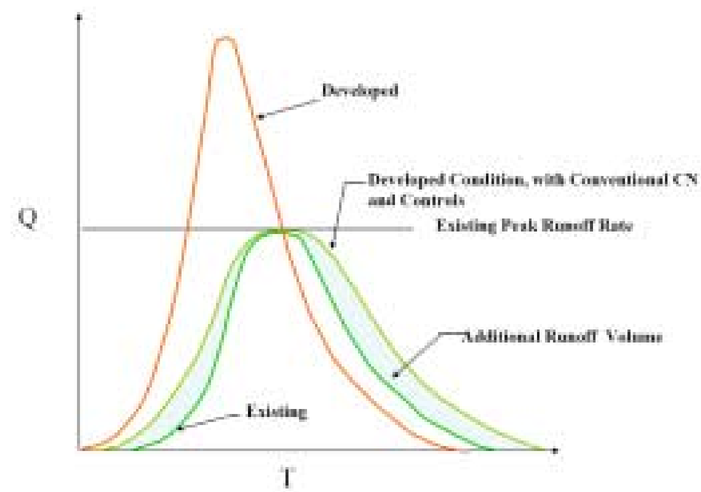
Precipitation	Cumulative Long-Term Volume of Precipitation	Volume Captured by Water Quantity Sized BMP
1-inch	60%	85%
1.32-inch (1/2 of 1-year)	72%	91%
2.6-inch (1-year)	93%	98%
3.2-inch (2-year)	96%	99%

Do design storms compensate for landuse change?

- **Protect stream geomorphology**
  - 1.5-year storm represents bank full conditions
  - Development shifts hydroperiods
  - Bankfull event vs. continuum
  - Typical measures in use
    - 1-year storm
    - 2-year storm
  - Results of peak discharge control
    - Regional
    - Microscale
- **Manage downstream flooding**
  - 10-year storm to protect manmade structures
  - 100-year storm to identify/protect floodplain

Design storms do not address all impacts

- **Reduced infiltration**
  - Reduction of volume infiltrated
  - Site of infiltration altered
  - Perennial stream become ephemeral streams
- **Aquatic habitat degradation**
  - Peak discharge controls extend increased velocity
  - Pollutant/sediment loads degrade habitat
- **Pollution**
  - Sediments
  - Nutrients
  - Toxics
  - Other



Volume control approach

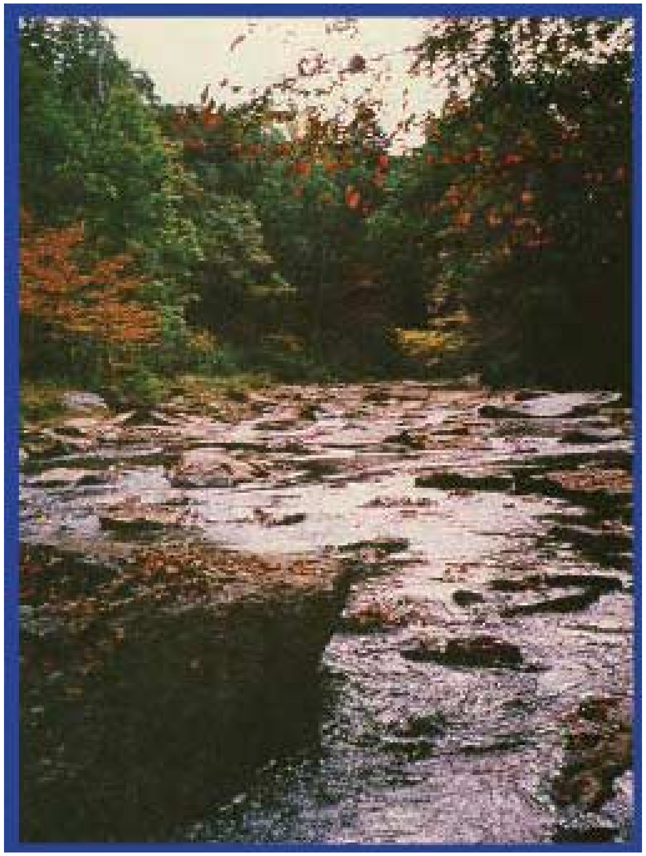
- **Applies to conventional and LID BMPs**
- **Does not necessarily promote LID**
- **Can manage the following wet weather impacts:**
  - **Physical stream protection**
    - **Key is selecting target design storm(s)**
    - **Can meet VA adequate outfall requirements**
  - **Infiltration**
    - **Can preserve RPAs**
    - **Reduces pollutant loads**
    - **No VA requirements**
  - **Water quality**
    - **Can lower pollutant loads**
    - **May not explicitly meet Chesapeake Bay Act requirements**

What will promote LID?

- **Design volume control, design storms, credit protection and other applications so the following claims can be reasonably defined:**
  - Full application of LID practices meets adequate outfall requirements
  - Volume control at microscale applications meets LID Design Manual guidance
  - Describe IMPs that relate WQ volume and LID BMPs to meet
    - **NPDES stormwater pollutant requirements**
    - **Chesapeake Bay Act pollutant requirements**

MS-19 Adequate Outfall compliance

- **MS-19 compliance recognizes the capture of the 1-year 24-hour stormwater runoff volume and its release over a 24-hour period as meeting the stream protection requirements**
- **The caveats are:**
  - **Peak flow check**
  - **Adequate outfall check**



LID Sizing Methodology 1

- **Capture 90% of stormwater runoff volume (~half of the 1-year storm)**
- **Infiltrate to the extent practicable to meet predevelopment infiltration/retention volumes**
- **Detain remaining flows for an extended period such that the 1-year predevelopment peak flow is not exceeded**
- **Work with state to find if this will be acceptable to meet MS-19 for stream protection without having to conduct adequate outfall analysis**

LID Sizing Approach 2

- **Same as Approach 1 except determine additional criteria needed to meet the MS-19 requirement for the 10-year peak flow control**
- **Determine the additional volume and extended detention needed**
- **These volumes/detention times may be near to the stream protection requirements**

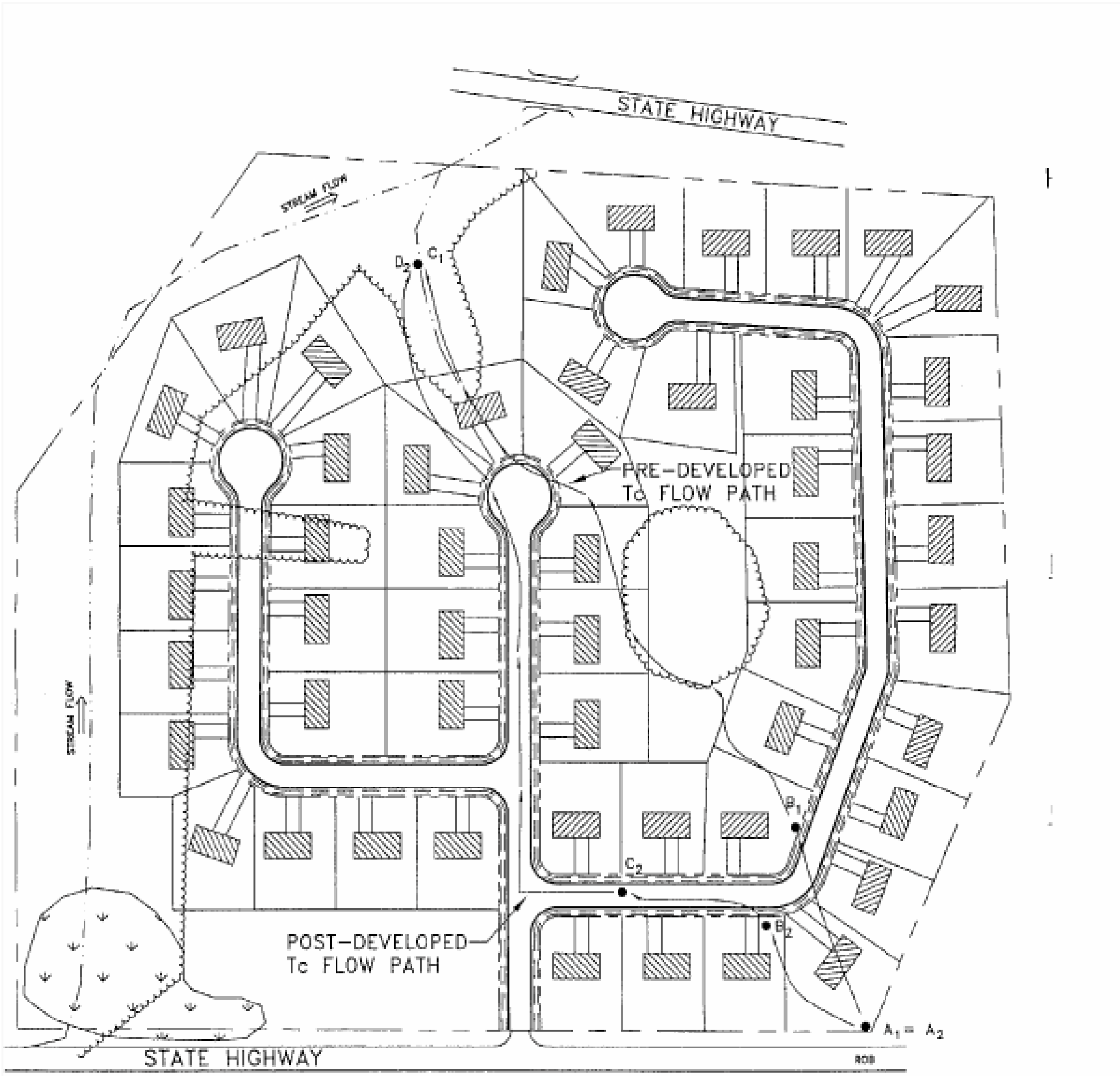
Next Steps

- **Work with Virginia DCR**
- **Evaluate a broad range of scenarios**
- **Identify variability in runoff capture volumes and duration of extended detention to achieve 2-year and 10-year MS-19 adequate outfall control**
- **LID Workgroup and Steering Committee select an LID Sizing Approach**

Examples

LID Designs Capture a 1-year Storm Volume

Reker Meadows



Source: 2000 Maryland Stormwater Design Manual

Site Characteristics		
Development	Pre	Post
Land Cover	**Woods Good**	
Impervious (%)	**0%**	**36%**
Connected (%)	**0%**	**50%**
Disconnected (%)	**0%**	**50%**
Soil Type	**60% B, 40% C**	
Curve Number	**61**	**78**

Note: Site Characteristics have been altered from original example.

Volume Methodology

Pre Development
Basin Characteristics
Land Cover / Soil Type / Basin Table

Basin	Land Cover	Soil	Area (ac)	CN
1a	Woods (good)	B	22.8	55
1b	Woods (good)	C	15.2	70

Post Development
Basin Characteristics
Land Cover / Soil Type / Basin Table

Basin	Land Cover	Soil	Area (ac)	CN
1a	Woods (good)	B	14.5	55
1b	Woods (good)	C	9.7	70
1c	Impervious	B	8.3	98
1d	Impervious	C	5.5	98

Area Disconnected Impervious = 6.9 ac

Runoff Volume Formulas

Runoff (in) = $(P-0.2S)^2 / (P+0.8S)$
P = 1 year rainfall = 2.6 in
S = 1000/CN-10

Runoff (ac-ft) = Q*A/12
Q = Runoff (in)
A = Area (ac)

Volume Credit (ac-ft) = Adis*1/4 (in) /12
Adis = Area Disconnected Impervious

Pre Development
Runoff Volume by
Land Cover / Soil Type / Basin

Basin	Runoff (in)	Runoff (ac-ft)
1a	0.10	0.19
1b	0.50	0.64

Pre Development Runoff = 0.83 ac-ft

Post Development
Runoff Volume by
Land Cover / Soil Type / Basin

Basin	Runoff (in)	Runoff (ac-ft)
1a	0.14	0.27
1b	0.89	1.12
1c	0.20	1.64
1d	0.20	1.09
Credit	*0.25*	*0.14*

Post Development Runoff = Runoff post – Credit
Post Development Runoff = 3.26 – 0.14
Post Development Runoff = 3.12 ac-ft

Infiltration Volume

Infiltration Volume = Runoff post – Runoffpre
Infiltration Volume = 3.12 – 0.83
Infiltration Volume = **2.29 ac-ft**

Water Quality Volume

Water Quality Vol = Runoff post – Infiltration Vol
Water Quality Vol = 3.12 – 2.29
Water Quality Vol = **0.83 ac-ft**

Site Characteristics

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Land Cover / Soil Type / Basin Table

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Runoff Equations

$$\text{Runoff (in)} = (P-0.2S)^2 / (P+0.8S)$$

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Runoff Volumes

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Land Cover / Soil Type / Basin

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Credit	*0.25*	*0.14*

Post Development Runoff = Runoff post – Credit
Post Development Runoff = 3.26 – 0.14
Post Development Runoff = 3.12 ac-ft

Results

Infiltration Volume

Infiltration Volume = Runoff post – Runoff pre
Infiltration Volume = 3.12 – 0.83
Infiltration Volume = **2.29 ac-ft**

Water Quality Volume

Water Quality Vol = Runoff post – Infiltration Vol
Water Quality Vol = 3.12 – 2.29
Water Quality Vol = **0.83 ac-ft**

Reker Meadows Volumetric Methodology Comparison (ac-ft)

<table>
<tr><th>Control Volume</th><th>NVRC 2006</th><th>PA 2006</th><th>MD 2000</th><th>PG County 1999</th></tr>
<tr><td>Infiltration</td><td>2.29</td><td rowspan="2">2.72</td><td>0.25</td><td>0.74</td></tr>
<tr><td>Water Quality</td><td>0.83</td><td>0.83</td><td>0.58</td></tr>
<tr><td>Channel Protection</td><td>0*</td><td>0*</td><td>0.57</td><td>0.00</td></tr>
<tr><td>Detention</td><td>0.83</td><td rowspan="2">2.72</td><td>1.08</td><td>1.31</td></tr>
<tr><td>Retention</td><td>2.29</td><td>0.57</td><td>0.00</td></tr>
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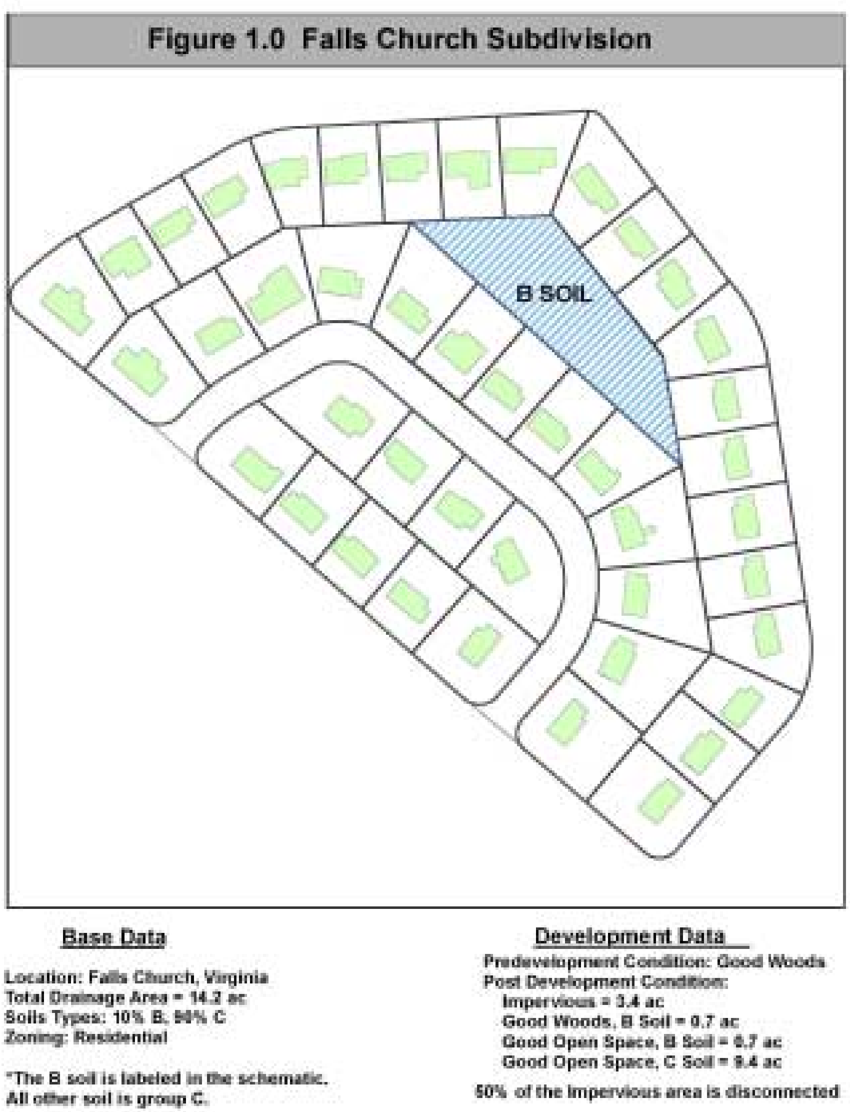
* Provided Tc post <= Tc pre

Example 2 – Falls Church Subdivision



- **Predevelopment**
  - Good Woods 14.2 acres
- **Post Development**
  - Impervious 3.4 acres
  - Good Woods (B) 0.7 acres
  - Good Open Space (B) 0.7 acres
  - Good Open Space (C) 9.4 acres
  - 50% of the impervious area is disconnected

Example 2 – Falls Church Results using NVRC Unified Approach

- **Retention Volume = 0.26 acre-ft**
  - Difference between Pre and Post 1yr Runoff
  - Volume Credit for disconnected impervious

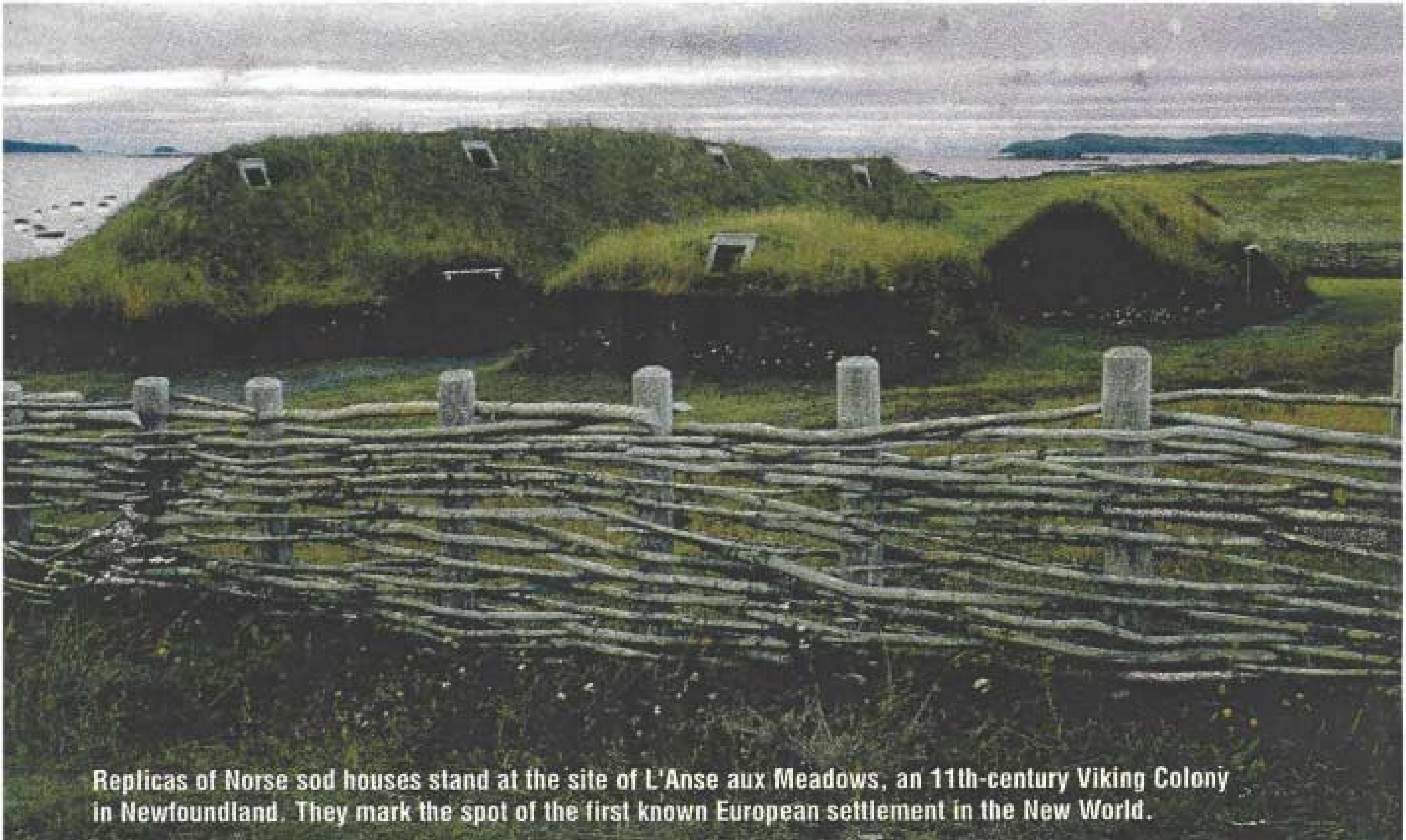
- **Water Quality Volume = 1.16 acre-ft**
  - Capture runoff from 1yr event
  - Volume Credit for disconnected impervious

- **Total Retention = 0.26 acre-ft**

- **Total Detention = WQ Volume – Retention Volume = 0.91 ac-ft**

Questions

When did low impact development concepts begin?



Replicas of Norse sod houses stand at the site of L'Anse aux Meadows, an 11th-century Viking Colony in Newfoundland. They mark the spot of the first known European settlement in the New World.

Copy of a National Geographic Society flyer, 2007